MICHAEL A. JACOBS (CA SBN 111664)
MJacobs@mofo.com
ARTURO J. GONZÁLEZ (CA SBN 121490)
AGonzalez@mofo.com
ERIC A. TATE (CA SBN 178719)
ETate@mofo.com
RUDY Y. KIM (CA SBN 199426)
RKim@mofo.com
MORRISON & FOERSTER LLP
425 Market Street
San Francisco, California 94105-2482
Telephone: 415.268.7000
Facsimile: 415.268.7522

KAREN L. DUNN (*Pro Hac Vice*)
kdunn@bsfllp.com
HAMISH P.M. HUME (*Pro Hac Vice*)
hhume@bsfllp.com
BOIES SCHILLER FLEXNER LLP
1401 New York Avenue, N.W.
Washington DC 20005
Telephone: 202.237.2727
Facsimile: 202.237.6131

Attorneys for Defendants
UBER TECHNOLOGIES, INC.
and OTTOMOTTO LLC

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

WAYMO LLC, Plaintiff, v. UBER TECHNOLOGIES, INC., OTTOMOTTO LLC; OTTO TRUCKING LLC, Defendants.	Case No. 3:17-cv-00939-WHA **EXPERT REPORT OF DR. PHILIP HOBBS ON CLAIM CONSTRUCTION** Trial Date: October 10, 2017

I. INTRODUCTION

A. Task

1. My name is Dr. Philip Hobbs. Uber Technologies, Inc. and Ottomoto LLC ("Uber") have asked me to opine on the meaning of certain claim terms in U.S. Patent No. 9,368,936 (the "'936 Patent"). I understand that Waymo has asserted the '936 Patent against Uber in the above-captioned case.

2. I have based the opinions provided in this report on my personal knowledge, professional judgment, experience, and analysis of the materials and information that I have considered in preparing this report. This report is based on information currently available to me. I reserve the right to supplement my analysis in this report to respond to any report prepared on behalf of Waymo or based on further analysis, discovery, or information provided in this case.

3. I am able to testify on the issue of claim construction at a hearing, if requested to do so, regarding the opinions in this report. I reserve the right to create summaries, tutorials, demonstrations, charts, drawings, tables, or animations that may be appropriate to explain or demonstrate my opinions if I am asked to testify at a hearing on claim construction.

4. My compensation for work on this case is $400 per hour plus any direct expenses incurred. My compensation is based solely on the amount of time that I devote to this case and is in no way affected by any opinions I provide. I receive no other compensation from work on this action. My compensation is not dependent on the outcome of this matter.

II. BACKGROUND AND QUALIFICATIONS

5. I have worked in the design and refinement of electro-optical and other mixed-technology systems for many years, including 21 years as a Research Staff Member at the IBM Thomas J. Watson Research Center in Yorktown Heights, New York and seven years in my own consultancy.

6. I have a Bachelor of Science degree in Astronomy and Physics from the University of British Columbia. I received the Master of Science and Ph.D. in Applied Physics from Stanford University in 1987. While at Stanford, I designed and built a scanning laser microscope

and associated analog and digital signal processing electronics, computer interface, software, and theoretical description.

7. After finishing my doctorate at Stanford, I joined IBM and until 2009 worked as a scientist and researcher at the Thomas J. Watson Research Center. There I invented and built dozens of advanced electro-optical instruments. Many of these were in the field of optical detection, including the laser noise canceller, an instrument that permits measurement accuracies as much as 10 million times below the laser noise; the world's first commercial atomic- and magnetic-force microscope; cavity-based diode laser stabilization at the shot noise level; and ISICL, an ultrasensitive scanning LiDAR for detecting and mapping individual contaminant particles in vacuum chambers. I was named an IBM Master Inventor, that is, a mentor to help other researchers through the process of writing and prosecuting patents.

8. I am currently Principal of ElectroOptical Innovations, a consultancy focused on electro-optical product design. In that capacity I have developed more than a dozen advanced instruments, including extending the state of the art in low-level, wideband optical detection with novel circuit architectures. I have also developed a number of spectroscopic sensors for applications as diverse as transcutaneous blood glucose/alcohol measurement, microplate readers, fire prevention, and the detection of blood spots in hens' eggs. I have also designed and built several high performance diode laser systems, including both the optics and electronics and some of the mechanics. I do nearly all my own circuit design, including advanced analog, switching power supplies, digital, microcontroller, logic, and interface electronics.

9. I have performed feasibility calculations on a number of novel LiDAR configurations for single-particle, meteorological, and vehicular applications.

10. I am a named inventor on 44 patents issued by the United States Patent and Trademark Office, almost all of which relate to electro-optical instruments. Through my work as an inventor and a mentor, I have gained experience in drafting and technical interpretation of patent documents. I have also had the opportunity to interview with examiners as part of the patent examination process.

11. I wrote a bestselling book on the subject: "Building Electro-Optical Systems: Making It All Work" (Second edition, Wiley, 2009; third edition forthcoming). In a major review, the book was described as "a new laboratory bible for optics researchers." (T. Siegman, Optics & Photonics News, January 2001). It covers both the optical and electronic aspects of instrument design and construction, and is widely used by electrical engineers, physicists, and others.

12. My curriculum vitae, attached as Appendix A of this Report, provide additional details of my education, experience, publications, and prior testifying experience.

III. MATERIALS CONSIDERED

13. I have considered the following materials in forming my opinions regarding the disputed claims terms and preparing this declaration:

- The '936 Patent, its prosecution history, and the prior art cited in the prosecution history.
- The parties' Patent Local Rule 4-2 disclosures of intrinsic and extrinsic evidence and materials cited in the disclosures.
- Waymo's Opening Claim Construction Brief.
- The Declaration of Dr. Andrew Wolfe, Ph.D Concerning Claim Construction of U.S. Patent No. 9,368,936.
- The deposition transcript of Dr. Andrew Wolfe.
- The deposition transcript of Samuel Lenius.

IV. LEGAL STANDARDS

14. I am not a lawyer, and I have relied on counsel for an understanding of the legal principles that apply in construing patent claims. I understand that the words of a claim are generally given their ordinary and customary meaning in view of the specification and prosecution history, which is the meaning that the term would have to a person of ordinary skill in the art (POSITA) at the time of the invention—in other words, as of the effective filing date of the

patent application. I further understand that the ordinary meaning of a claim term is its meaning to a POSITA after reading the entire patent.

15. I understand that the claims themselves provide substantial guidance as to the meaning of particular claim terms and that the context of the surrounding words of the claim also must be considered. I further understand that the other claims of the patent, both asserted and unasserted, can be valuable sources of information because claim terms normally are used consistently throughout the patent. I also understand that differences among claims can be a useful guide—for example, where a dependent claim adds a particular limitation, one can presume that the independent claim does not include that limitation.

16. I understand that a claim, when read in light of the specification and the prosecution history, must provide objective boundaries as to what is being claimed, from the perspective of one of skill in the art. I understand that if a claim fails to apprise a POSITA of the boundaries of the claim, or if the claim fails to give notice to the public of what is still open to them, then the claim is considered to be indefinite. I also understand that a patent claim is invalid for indefiniteness if its claims, read in the light of the patent specification and file history, fail to inform with reasonable certainty those skilled in the art about the scope of the invention.

17. I understand that the specification is always highly relevant to the claim construction analysis. I understand that the specification usually is dispositive and is the single best guide to the meaning of the claim term in question. I also understand that the specification may reveal a special definition that the patentee gave to a claim term that differs from the meaning the term otherwise would possess. I understand that, in such cases, the patentee's lexicography governs. I understand that even when the specification describes only a single embodiment, the claims of the patent are not read restrictively unless the patentee has demonstrated a clear intention to limit the claim scope using words or expression of manifest exclusion or restriction.

18. In addition, I understand that the patent's prosecution history is part of the intrinsic evidence and should be considered. I understand that the prosecution history is the complete

record of the proceedings before the United States Patent and Trademark Office (USPTO) and includes the prior art cited during the patent's examination. I understand that the prosecution history often can inform the meaning of the claim language by demonstrating how the inventor understood the invention and whether the inventor limited the invention during prosecution, making the claim scope narrower than it otherwise would have been. I understand, however, that a disavowal of claim scope in the prosecution history must be clear and unmistakable.

19. I understand that, in some cases, it is appropriate to consult extrinsic evidence to understand the background science or meaning of a term in the relevant art during the relevant time period. I understand that extrinsic evidence consists of all evidence external to the patent and prosecution history and includes expert and inventor testimony, dictionaries, and learned treatises. I further understand that technical dictionaries can be helpful in determining the meaning of a claim term to POSITAs because such dictionaries endeavor to collect the accepted meanings.

20. Finally, I understand that the construction that stays true to the claim language and most naturally aligns with the patent's description of the invention is the correct construction. I understand that a claim interpretation that excludes the inventor's device, as described in the specification, is rarely correct.

V. LEVEL OF SKILL

21. In my opinion, a person of ordinary skill in the art at the time of the invention would have a bachelor's degree in electrical engineering, physics, engineering physics, or an allied field, and at least three years of experience of designing electro-optical circuits to power and control light emitting devices such as a laser diode. At the time of the invention of the '936 Patent, I met and exceeded these qualifications. My determination of the level of skill is based on my work experience as of the filing date of the '936 Patent, as well as my experiences in designing and testing electro-optical circuits like the one discussed in the '936 Patent.

VI. BACKGROUND

22. The ’936 Patent discloses a step-up circuit employed within a firing system for a laser diode, using well-known circuit elements like inductors, diodes, and capacitors that are configured in a specific arrangement to create a step-up circuit. A step-up circuit is designed to charge a capacitor to a voltage that is greater than the voltage of the voltage source that powers this circuit and to use this voltage to power some load. In a battery-powered device, a POSITA uses a step-up circuit to produce a high voltage without having to utilize an inconveniently large or inefficient battery to do so. A step-up circuit uses an inductor in series with a diode to charge a load such as a capacitor. Below, I describe the elements that make up a step-up circuit, as well as how the elements of a step-up circuit work together to create the desired effect.

23. An inductor acts to oppose changes to current flow passing through it. An inductor is generally a coil of wire that is often wound on a core made of ferromagnetic material such as ferrite or silicon steel so as to increase the magnetic (**B**) field produced. The common circuit symbol for an inductor is shown below.

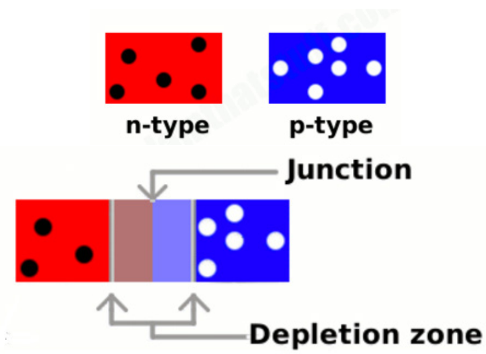
24. The operation of an inductor can be described in three situations: (i) when current is increasing through the inductor, (ii) when it is constant, and (iii) when current is decreasing through the inductor. The voltage induced across an inductor is proportional to the rate of change of current. When current is increasing through the inductor, the voltage so induced across the inductor tends to oppose the increase in the current. The work done by the current against this induced voltage is converted to magnetic field energy.

25. The current cannot go on increasing indefinitely, so at some point it has to reach a peak value where the current is (for the moment) constant. At this point, the rate of change is zero, and the induced voltage is also zero. As current through the inductor decreases, once again the induced voltage will oppose the change in current, but now instead of storing energy it releases it back to the external circuit.

26. The role of a diode within a circuit is to allow current to flow in one direction and prevent current from flowing in the opposite direction. The symbol for a semiconductor diode is shown below.

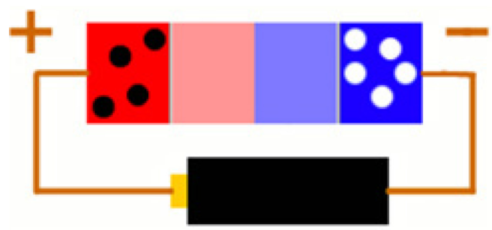
27. A semiconductor diode (the type that is used nearly exclusively in the art) works by forming p-type and n-type semiconductor materials in intimate contact. N-type semiconductor material is created by doping a semiconductor such as silicon with a small proportion of atoms such as phosphorus that have an extra valence electron (five in all), whereas P-type material is doped with atoms having one less valence electron (three in all).

28. The net effect is that (while remaining electrically neutral) N type material has free electrons (negative charge carriers) while P-type material has free holes (positive charge carriers). Holes behave a lot like positive electrons, since they are free to move under the influence of the local electric field but move in the opposite direction to the electrons. When an n-type semiconductor material is joined with a p-type semiconductor, a diode is created as shown below.

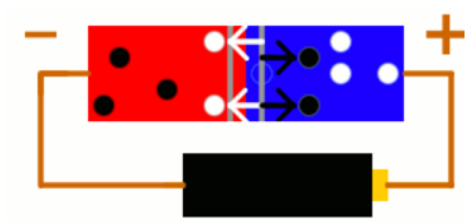


29. The side of the device containing the n-type material is known as the cathode. The side of the device containing the p-type material is known as the anode. Since the cathode material is electrically connected to the anode material, both electrons and holes will flow across the junction by diffusion. If nothing restrained them, they would distribute themselves equally throughout the diode. However, electrons leaving the N region leave behind extra positive charge, causing an electric field pointing towards the anode. Similarly, holes leaving the P region leave behind negative charge, whose resulting field adds to that due to the motion of the

electrons. This electric field opposes the diffusion, so a steady state is established with a "frozen in" field just sufficient to pull in enough carriers to cancel out the diffusion current. This "frozen in" field causes the free carriers to move out of the neighborhood of the junction so that a *depletion zone* forms and no net current flows. However, when a voltage is applied to the device, the resulting electric field adds with the "frozen in" field. If the cathode is made more positive (reverse bias), the two fields are both directed towards the anode, their magnitudes add, which attracts the electrons to the cathode and the holes towards the anode more strongly, causing the depletion zone to widen, as shown below.



30. If the anode is made more positive (forward bias) the applied field opposes the "frozen in" field. As the applied voltage increases, the depletion zone becomes narrower and eventually disappears, allowing carriers to stream freely: electrons to the anode and holes to the cathode. The resulting current flow is illustrated below.

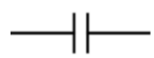


31. Thus, when the diode is forward biased, current is allowed to flow from the anode to the cathode, and when the diode is reverse biased, current is prevented from flowing within the diode.

32. Ideally, the diode will only allow for current flow in one direction when forward-biased and prevent current flow when reverse biased. However, even when the diode is reverse biased, the device may allow a small, generally negligible current to flow through it. This current is known as leakage current. Circuit designers generally ignore leakage current, and on the rare occasions when that is not possible, leakage current is regarded as a nuisance. Leakage current is

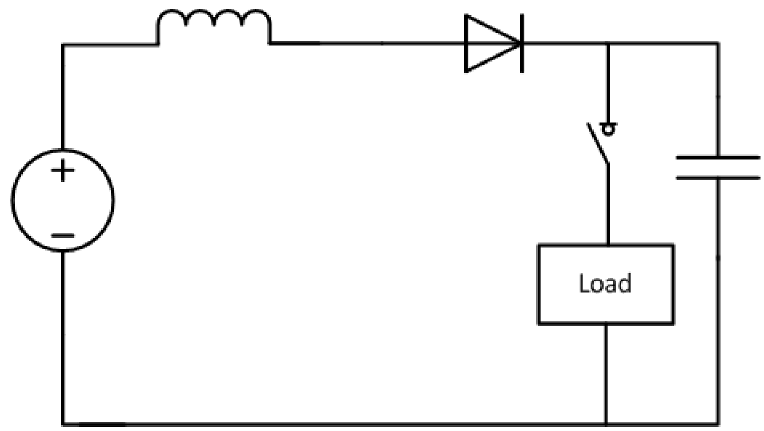
disregarded because it is generally orders of magnitude smaller than the current that flows through the diode when it is forward biased. In most cases, except very near zero bias, leakage current is one million to one billion times smaller than the current that flows through diode when it is forward biased at the same voltage. This is especially true when the diode is employed in a laser diode firing system, where the reverse bias is large and the duty cycle is low, so that energy must be stored many times longer than the pulse duration. Because the leakage current of a diode is so miniscule as compared to the forward biased current, its contribution is often ignored when designing a circuit.

33. The role of a capacitor in a circuit is to store charge. The symbol for a capacitor is provided below.

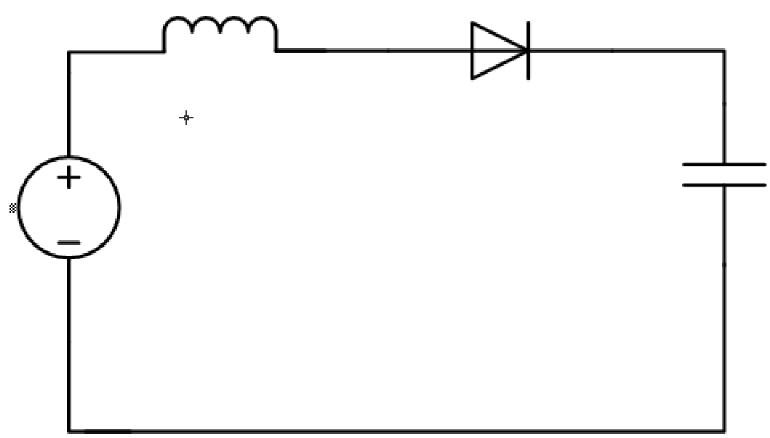


34. A capacitor generally includes two metal plates that are separated by a dielectric material. When current flows on to the metal plates, an electric field is created. Positive charge will collect on one plate, while a negative charge will collect on the other plate. The resulting stored charge creates an electric field across the dielectric, and this field stores energy in a similar way to the magnetic field in an inductor.

35. An inductor, diode, and a capacitor can be specifically arranged to create a step-up circuit. The purpose of a step-up circuit is to charge the capacitor to a voltage that is higher than the voltage of the source that provides the circuit with power. This allows a circuit designer to employ a smaller battery to power their design than what would be required if a step-up circuit wasn’t used. An example step-up circuit is provided below.



36. The above circuit operates in two modes, a charging mode and discharging mode. When the circuit is in the charging mode, the switch that connects the load in parallel to the capacitor is open. Because the switch is open, the load is no longer on any path that current will flow through, and the circuit will effectively look like the circuit illustrated below.



37. The step-up circuit is configured to "supercharge" the capacitor (i.e., charge the capacitor to a voltage greater than the voltage source). When the capacitor is discharged, current will flow from the voltage source through the inductor. Because the inductor will oppose any changes in current, initially the work done by the current against the induced voltage of the inductor is converted to energy that is stored in the magnetic field of the inductor, and the work

done by the current against the capacitor voltage is stored in the electric field of the capacitor, so that ideally none is wasted. For this circuit to operate properly, losses in the inductor should be kept reasonably low, so that it can function effectively as an energy storage device. When the capacitor's voltage crosses through the supply voltage, the voltage across the inductor changes sign, so the current starts to decrease. Since the current is still in the same direction and the voltage is now in the opposite one, energy flows from the inductor's magnetic field into the capacitor, still ideally without loss.

38. Because current is still flowing into the capacitor, its voltage continues to increase. It thus rises above the supply voltage, and continues to do so until the current in the inductor falls to zero, which in the lossless case will be when the capacitor is charged up to twice the supply voltage.

39. If there were no diode to prevent it, the current in the inductor would continue to become more negative, and the LC circuit would ring sinusoidally. However, the diode stops this from happening because it becomes reverse biased, so that the sinusoid is frozen at its peak value. In other words, once the diode is reverse biased, no current can flow through it, and therefore the charge on the capacitor will become "trapped." The capacitor will now hold and maintain a charge that is greater than the voltage of the voltage source. In this way, the voltage of the power supply is "stepped-up" to a greater voltage that is now stored on the capacitor.

40. The step-up circuit discussed above is a conventional circuit that has been developed and employed in various applications for decades. As an example, U.S. Patent No. 4,648,093 to Sasnett ("Sasnett"), filed over 30 years ago in 1984, discusses the use of a step-up circuit in the context of a laser diode firing system. FIG. 2 of Sasnett (reproduced below with annotations) includes the same series-connected power supply, inductor, diode, and capacitor step-up circuit described above.

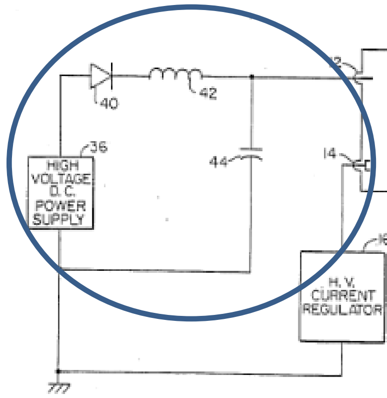


FIG. 2.

41. Sasnett describes a circuit that is configured to "supercharge" capacitor 44 so that the stored charge can be made available to a gas discharge laser 10 thereby causing the laser to emit light. (Sasnett's laser tube functions as both the current switch and the light emitter, since no current flows until the discharge is struck.) Sasnett describes the operation of the step-up circuit explaining that "***capacitor 44 is charged to a potential equal to the potential across inductor 42 plus the potential of high voltage DC power supply 36***. Diode 40 prevents discharge of capacitor 44 into high voltage DC power supply 36 when capacitor 44 is charged above a potential equal to that of high voltage DC power supply 36." (Sasnett at 5:49-63, (emphasis added)).

VII. SUMMARY OF THE '936 PATENT

42. The '936 Patent is generally directed to a laser diode firing system that is employed in a light detection and ranging (LIDAR) device. The laser diode firing system disclosed in the '936 Patent, when triggered, delivers a short, intense pulse of electrical current to a laser diode that causes the laser diode to emit a powerful and very brief pulse of light. To deliver the pulse of current to the laser diode, the firing system includes a storage capacitor that stores charge during a charging process and then discharges the stored charge into the laser diode during a discharge process.

43. FIG. 5A (reproduced below) of the '936 Patent illustrates an exemplary laser diode firing system that is described throughout the specification.

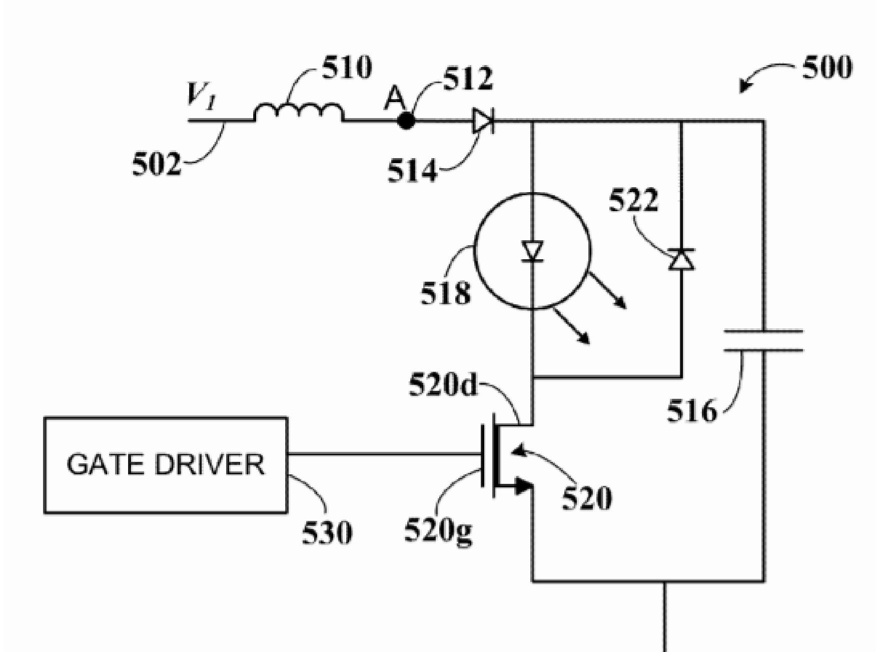


Figure 5A

44. The circuit illustrated in FIG. 5A includes a transistor 520 that acts like a switch, which controls the charging and discharging of the capacitor as well as the firing of the laser.

45. The circuit operates in a charging configuration when transistor 520 is switched off (i.e., there is no voltage applied to the gate 520g). I have provided an annotated FIG. 5C below to illustrate what the configuration of the circuit effectively becomes when the transistor 520 is turned off.

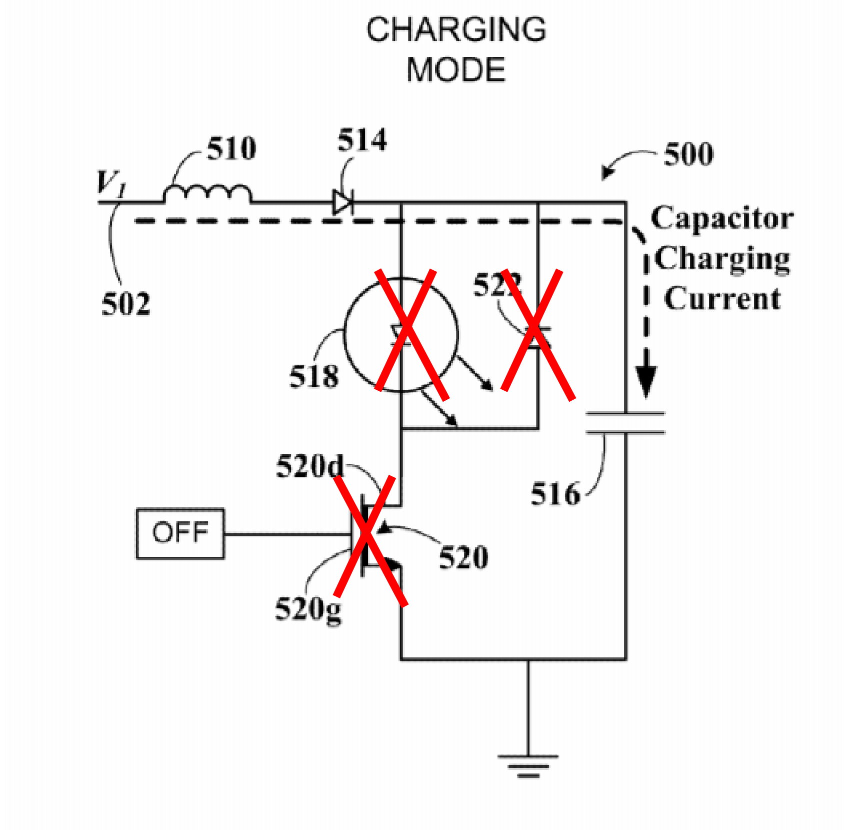


Figure 5C

46. When the transistor 520 is off, it creates an open circuit across the transistor. Since there is no longer a path to ground that goes through laser diode 518 and discharge diode 522, those circuit elements can be disregarded as they no longer are part of a path that current will take in the circuit. The circuit elements that are still active in the charging configuration include a voltage source 502 in series with an inductor 510, a diode 514, and a capacitor 516. This specific arrangement of the inductor, diode, and capacitor is a step-up circuit. The operation of the circuit in the charging configuration is to step- up the voltage of the voltage source and store the increased voltage at capacitor 516. Ultimately, the stepped-up voltage on the capacitor 516 is made available to the laser diode 518 when the circuit switches into the discharge mode.

47. When the circuit is in the charging configuration, it utilizes the step-up circuit to charge capacitor 516 to a voltage that exceeds the voltage source 502. The current from voltage source 502 enters the inductor 510, which initially stores the current as energy in a magnetic field. Over time, the voltage across the capacitor will become approximately equal to the voltage source

502, as the capacitor stores the charge flowing from the voltage source. As the voltage of the capacitor 516 approaches the voltage of voltage source 502, the inductor will release its stored energy, which will then flow as current into the capacitor, thereby supercharging it.

48. When transistor 520 is turned on by the gate driver, the capacitor is discharged rapidly through the laser diode, which emits a pulse of light lasting a few nanoseconds, after which the transistor is turned off again, leaving the voltage on the capacitor much lower than the supply voltage 502. At this point, the transistor and the two diodes have effectively disappeared from the circuit, as shown in the annotated version of FIG. 5C above.

49. As the capacitor discharges, the voltage across the capacitor will decrease over time. When the voltage on the capacitor falls below the supply voltage 502, current begins to flow from the supply through inductor 510 and diode 512. Because the diode is now forward-biased (since the voltage across the capacitor is below the supply voltage), it allows current to flow freely into the capacitor so that it represents only a minor perturbation on the resonant *LC* circuit formed by inductor 510 and capacitor 520. This *LC* circuit rings at its free resonance, so that the voltage and current waveforms in the capacitor are approximately sinusoidal but 90 degrees out of phase: the current goes like the sine and the voltage like the cosine.

50. If the ringing were allowed to continue (i.e., if diode 512 were replaced with a wire), the average voltage on the capacitor would equal the supply voltage. Since the ringing waveform is nearly symmetrical and the voltage on the capacitor is initially small, it peaks at approximately twice the supply voltage, at which point the current falls to zero. However, the diode prevents this ringing from continuing past the half cycle.

51. Since practically no current can flow backwards through the diode, the charge on the capacitor is prevented from flowing back to the supply as it would in a pure resonant circuit. Instead, the ringing is stopped by the diode: the voltage on the capacitor retains its peak value until the next time the gate driver turns on the transistor.

52. The ’936 Patent’s description of the operation of the circuit illustrated in FIG. 5A is commensurate with the description of how a step-up circuit works. The ’936 Patent explains

that "[u]pon the voltage at node A 512 approximately equaling the voltage on the capacitor 516, the diode 512 is reverse biased. Upon the diode 514 being reverse biased, the current through the inductor 510 goes to zero and the voltage across the inductor 510 settles at zero, which sets node A to the voltage of the voltage source 502 (e.g., the voltage V_1), ***but the capacitor 516 may hold a higher voltage (e.g., about 2*** V_1***)***." ('936 Patent at 18:60-67 (emphasis added)).

53. FIG. 5D (reproduced below) illustrates the operation of the circuit during the discharge mode.

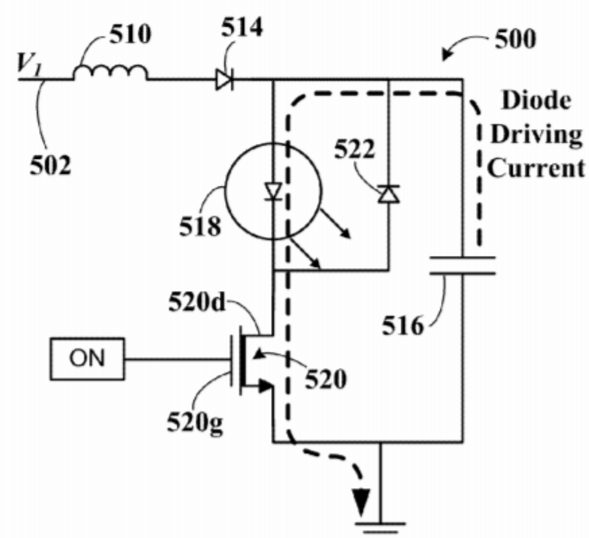


Figure 5D

54. As illustrated in FIG. 5D, when the transistor 520 is switched on (i.e., a voltage is applied to gate 520g), a path to ground is created from the capacitor 516 through the laser diode 518. The charge stored in the capacitor 516 will now have a path to ground by which to discharge. The charge stored in the capacitor flows through the diode 518 as a short pulse that causes the diode to emit a pulse of light. The extra voltage stored up in the capacitor 516 during the charging mode of the circuit helps to ensure that the current that pushed through the laser diode 518 is sufficient to cause the diode to emit light. The inductor improves the efficiency of the circuit by storing and returning energy that would otherwise be dissipated.

VIII. ANALYSIS OF DISPUTED TERMS

A. "Diode" (claims 1, 9, 17)

55. It is my understanding that the parties as well as Dr. Wolfe propose the following constructions of the term diode as it appears in claims 1, 9, and 17 of the '936 Patent.

Uber's Construction	Waymo's Construction	Dr. Wolfe's Construction
"a two-terminal electronic device that allows the flow of current in one direction only"	Plain meaning	"a two-terminal electronic device that will conduct electricity much more easily in one direction that in the other"

56. As reflected in the chart above, the only disagreement between the parties is whether the construction of diode should include language that accounts for the leakage current phenomenon associated with diodes. In my opinion, Uber's construction is consistent with how a POSITA would understand the term in view of the intrinsic evidence. As explained below, the '936 Patent regards the leakage current in the diode as non-existent. The specification consistently discusses the operation of the laser diode firing system assuming that the leakage current does not exist. In my opinion, construing the term diode to account for leakage current would be inconsistent with the specification of the '936 Patent and would be unnecessary and confusing. In light of the specification of the '936 Patent, a POSITA would understand the term "diode" to mean "a two-terminal electronic device that allows the flow of current in one direction only."

57. The '936 Patent's discussion of the diode is consistent with a POSITA's understanding of the function of a diode in a circuit. FIG. 5A of the '936 Patent (reproduced below, with annotations) provides the context in which the claimed "diode" is used.

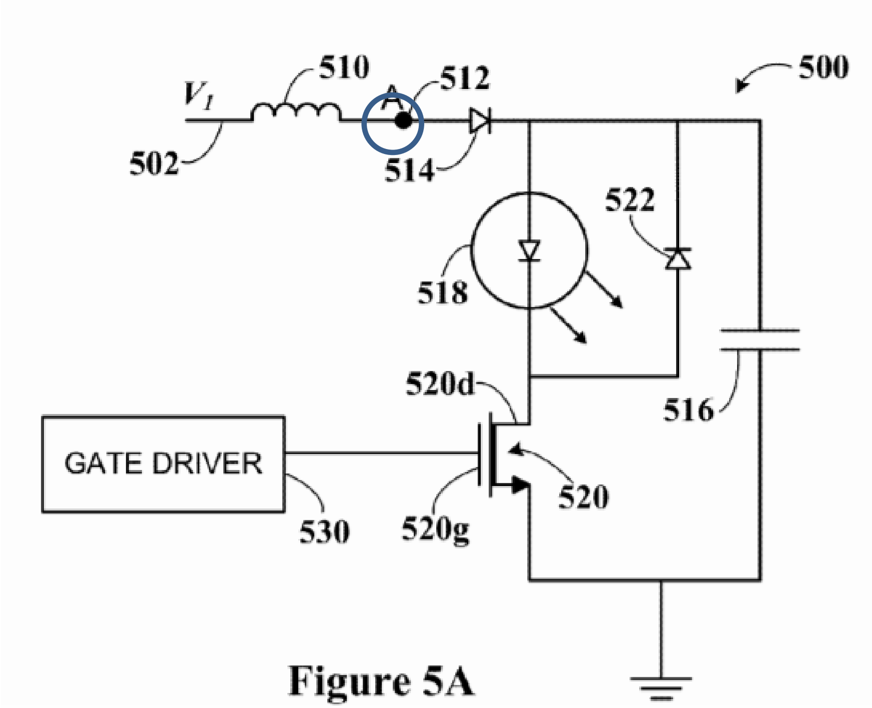


Figure 5A

58. Element 514 represents the diode that is recited in claims 1, 9 and 17 of the ’936 Patent. The ’936 Patent’s specification explains that “the diode 514 regulates the voltage applied to the capacitor 516 depending on whether the diode 514 is forward biased or reverse biased.” (’936 Patent at 18:32-35). With respect to the operation of the diode 514 when it is forward biased, the specification explains that “[t]he diode 514 is forward biased (and thus allows the capacitor 516 to charge) when the voltage at node A 512 is greater than the voltage on the capacitor.” (*Id.* at 18:35-37). In other words, when the voltage at the anode of the diode 514 (i.e., node A) is greater than the voltage of the cathode (i.e., the voltage on the capacitor), the diode allows current to flow from the anode to the cathode, thus allowing for the capacitor 516 to charge.

59. With respect to the operation of the diode 514 when it is reverse biased, the specification explains that “[t]he diode 514 is reversed biased (and thus prevents the capacitor 516 from charging) when the voltage at node A 512 is less than the voltage.” (*Id.* at 18:37-40). The ’936 Patent, in discussing the operation of the diode when it is reversed biased, explicitly disregards any leakage current explaining that “[u]pon the diode 514 being reverse biased, the current through the inductor 510 ***goes to zero*** and the voltage across the inductor **settles at**

zero. . .” (*Id.* at 18:62-64(emphasis added)). If the ’936 Patent regarded the effects of leakage current in its description of the diode, then the current through the inductor would not go to zero, nor would the voltage across the inductor settle at zero. Rather the inductor when the diode is reverse biased would have a small leakage current flowing through it that would cause a small voltage across the inductor’s series resistance.

60. In my opinion, the ’936 Patent disregards the leakage current of the diode because the leakage current is negligible as compared to the current that is flowing through the diode when it is forward biased. I have attached as an appendix to my report, a product data sheet for an exemplary diode that could be used in the circuit of FIG. 5A of the ’936 Patent. (*See* Appendix B). The product sheet is a true and accurate copy of the product sheet of PMEG10010ELR, a diode manufactured by Nexperia. The product sheet states that the leakage current in the diode is in the range of 40-150 nanoamps. (*Id.* at 1 (*see* excerpt below)).

Table 1. Quick reference data

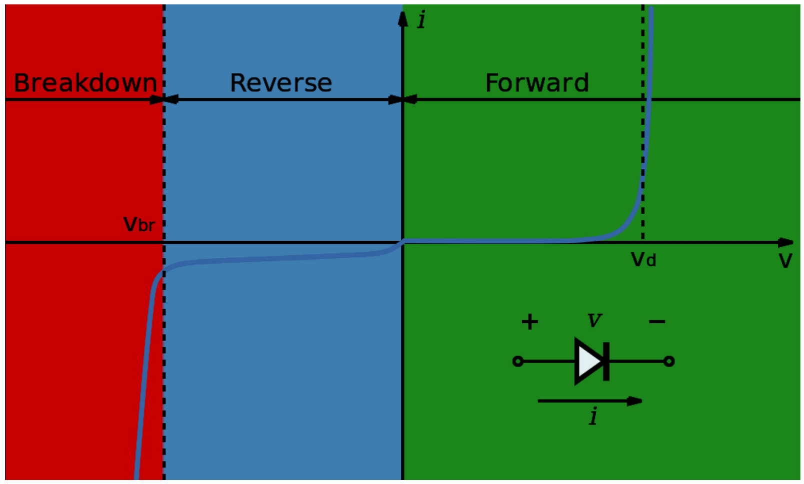
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$I_{F(AV)}$	average forward current	square wave; $\delta = 0.5$; $f = 20$ kHz; $T_{sp} \leq 170$ °C		-	-	1	A
V_R	reverse voltage	$T_j = 25$ °C		-	-	100	V
V_F	forward voltage	$I_F = 1$ A; $t_p \leq 300$ µs; $\delta \leq 0.02$; $T_j = 25$ °C		-	710	770	mV
I_R	reverse current	$V_R = 100$ V; $t_p \leq 300$ µs; $T_j = 25$ °C; $\delta \leq 0.02$		-	40	150	nA

61. In contrast, the current that flows through the diode when it is forward biased is on the order of a hundred milliamps. The specification of the ’936 Patent states that “[a]n example circuit may switch from near zero current through the laser diode, to about 30 amperes, and back to near zero all in a span of about 1-2 nanoseconds.” (’936 Patent at 17:37-40). Claim 13 of the patent recites that “the charging of the capacitor is carried out in about 500 nanoseconds.” Since current is inversely proportional to the time it takes to charge or discharge a capacitor, the current flowing through the diode is a few hundred times less than the peak diode current, i.e., on the order of a hundred milliamps.

62. This means that the current flowing through the inductor during the charge period is approximately a million times greater than the leakage current of the diode. It has no

significant impact on the operation of the circuit and is therefore negligible. In my opinion, this is why the '936 Patent simply ignores the leakage current when describing how the circuit operates.

63. Dr. Wolfe's testimony includes misleading demonstratives in his description of leakage current. As an example, Dr. Wolfe provides the graph reproduced below.



64. The chart provided by Dr. Wolfe, which is supposed to illustrate a voltage v. current graph of a diode, does not include a scale. However, the graph makes it appear as though the reverse current (i.e., the current in the blue region) is larger or on the same order of magnitude as the current when the diode is forward biased (shown in the green region). This of course is false. The leakage current will be many orders of magnitude smaller.

65. In my opinion, in light of the intrinsic evidence above as well as a POSITA's common understanding, the term diode should be construed to mean "a two terminal electrical device that allows the flow of current in one direction only," as proposed by Uber.

B. "charging path" (claims 1, 9, 17)

66. It is my understanding that the parties propose the following constructions of the term "charging path" as it appears in claims 1, 9, and 17 of the '936 Patent.

Uber's Construction	Waymo's Construction
"a path allowing current to flow from the inductor to the capacitor, the path configured to charge the capacitor to a voltage higher than the supply voltage"	Plain meaning

67. In my opinion, the term "charging path" does not have a plain and ordinary meaning outside of the context of the '936 Patent, and Uber's construction of "charging path" is consistent with how a POSITA would understand the term in view of the intrinsic evidence.

68. Independent claims 1, 9, and 17 introduce the phrase "charging path" in the context of reciting the elements and operation of a step-up circuit. The term charging path is introduced into the independent claims by reciting (in part) "a capacitor coupled to *a charging path* and a discharge path." (Emphasis added).

69. The independent claims go on to define the elements of the "charging path," reciting "wherein the charging path includes the inductor and the diode." Of course, as described above in the background section of my report, an inductor and a diode are components that when arranged in a specific manner, form a step-up circuit. The in-series inductor, diode, and capacitor circuit arrangement form an identical circuit to the step-up converter in the charging mode as illustrated in the background section. The independent claims state that the inductor, the capacitor, and the diode are in series. For instance, claim 1 recites "an inductor coupled to the voltage source, wherein the inductor is configured to store energy in a magnetic field" and also recites "a diode coupled to the voltage source via the inductor," and then goes on to recite that the "charging path includes the inductor and the diode." Thus a POSITA, based on the claim language, would understand that the "charging path" is a step-up circuit.

70. The claim language also states that the charging path (and its elements) are configured to charge a capacitor. The independent claims recite "wherein, responsive to the transistor being turned off, the capacitor is configured to charge via the charging path such that a voltage across the capacitor increases from a lower voltage level to a higher voltage level." A POSITA would thus understand that the purpose of the recited "charging path" is to increase the voltage across a capacitor.

71. Finally, the claims recite how the "charging path" increases the voltage across the capacitor. The recitation of the operation of the "charging path" informs a POSITA that the claimed "charging path" is a step-up circuit. The claims recite that "responsive to the transistor

being turned off, the capacitor is configured to charge via the charging path such that a voltage across the capacitor increases from a lower voltage level to a higher voltage level and the inductor is configured to release energy stored in the magnetic field such that a current through the inductor decreases from a higher current level to a lower current level." This description is commensurate with the description of how a step-up circuit operates.

72. As discussed above in the background section, a step-up circuit employs an inductor that releases energy stored in a magnetic field to "supercharge" a capacitor (i.e., charge the capacitor to a voltage greater than the voltage source). Since the claims require that the charging path include an inductor that releases energy stored in the magnetic field and that the charging path increases the voltage level on the capacitor, one of skill in the art would conclude that the recited "charging path" is a step-up circuit.

73. The limitations in the claims that describe the "charging path" are consistent with a POSITA's knowledge of how step-up circuits work. The claims recite that the voltage at the capacitor is increased, and the claims further recite that the increase in voltage is due to an inductor releasing energy stored in its magnetic field. In my opinion, a POSITA would understand that the "charging path" is topologically a step-up circuit.

74. The specification of the '936 Patent is consistent with interpreting the term charging path as a step-up circuit. The specification discusses only one type of charging path, a path that allows for the voltage on the capacitor to charge to a voltage higher than the supply voltage. For instance the '936 Patent explains that "[t]he diode 514 and inductor 510 can thus combine to cause the capacitor 516 to be charged to a voltage that exceeds the voltage V_1 of the voltage source 502." ('936 Patent at 21:40-42). The specification goes on to explain that during the charging mode "the diode 514 is forward biased when the voltage across the capacitor 516 is at a lower level, such as between time times [sic] T_{OFF} and T_2 as shown in FIG. 5B when the capacitor voltage V_{cap} charges from less than ***V_1 to about 2 V_1***. . . ." (*Id.* at 21:42-46(emphasis added)).

75. FIG. 5B (reproduced below, with annotations) also illustrates that the circuit is configured to cause the voltage across the storage capacitor (V_{cap}) to exceed the voltage of the power supply. As shown in the figure, V_{cap} (the voltage across the capacitor) is charged to 2 $V_{1,}$ which is twice the voltage of the source.

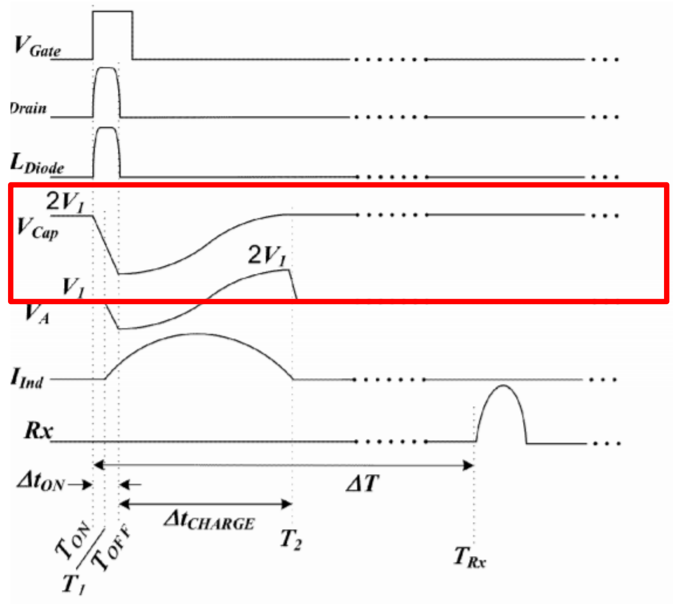


Figure 5B

76. Given that each embodiment in the specification discloses that the charging path is a step-up circuit, and the claims of the '936 Patent themselves describe the charging path operating in the manner of a step-up circuit, in my opinion, the construction of the term "charging path" should recognize that the charging path is a step-up circuit. Uber's proposed construction of the term charging path, "a path allowing current to flow from the inductor to the capacitor, the path configured to charge the capacitor to a voltage higher than the supply voltage," is wholly consistent with a POSITA's understanding of the term in light of the intrinsic evidence.

C. "immediately" (claims 3, 11, 19)

77. It is my understanding that the parties propose the following constructions of the phrase "wherein the capacitor is charged immediately following emission of a pulse of light from the light emitting element" as it appears in claims 3, 11, and 19 of the '936 Patent.

Uber's Construction	Waymo's Construction
Indefinite	Plain meaning

78. In my opinion, a POSITA in reading the specification of the '936 would not be able to determine the bounds of the term "immediately," and thus the limitation in which the term "immediately" appears is indefinite.

79. First of all, I disagree with Waymo's interpretation of the action that is occurring "immediately following emission of a pulse of light from the light emitting element." Waymo alleges that the phrase "refers to the transition between a discharge cycle and charge cycle of the firing circuit." (Waymo Claim Construction Brief at pg. 18, lines 11-13). Thus, Waymo alleges that the action that precedes the term "immediately" refers to the capacitor beginning its charging cycle. That is not what the plain language of the claim is reciting. Instead, the limitation recites: "wherein the capacitor is ***charged immediately***." The limitation refers to the capacitor being charged completely, and thus in my opinion, the limitation requires that the capacitor be fully charged immediately, rather than merely begin charging immediately as Waymo alleges.

80. The specification of the '936 Patent supports this interpretation. The specification describes "a capacitor recharging interval" that allows the capacitor to fully charge in 500 nanoseconds after the laser discharge completes:

> As shown in FIG. 5B, a capacitor recharging interval Δt_{CHARGE} begins at the transistor turn off time T_{OFF} and ends with the reverse biasing of the diode 514, at time T_2. ***The capacitor recharging interval Δt_{CHARGE} may be approximately 500 nanoseconds***, for example. Moreover, by configuring the firing circuit 500 such that the capacitor 516 is recharged immediately following a pulse emission, the firing circuit 500 can be recharged and ready to emit a subsequent pulse faster than an alternative configuration."

('936 Patent at 21:55-64 (emphasis added)).

81. Given the use of the term "charged" in the sense of completion, and the specification's discussion of the charging interval, a POSITA would understand that the phrase "wherein the capacitor is charged immediately following emission of a pulse of light from the light emitting element" refers to the amount of time that it takes to fully charge the capacitor and

not, as Waymo alleges the transition between a discharge cycle and charge cycle of the firing circuit.

82. In my opinion, given some charging circuit not identical with an embodiment in the specification, a POSITA would be unable to determine whether a capacitor fully charges immediately as required by the claims. The specification at best only provides one guidepost, stating that the "the capacitor recharging interval Δt_{CHARGE} may be approximately 500 nanoseconds." ('936 Patent at 21:58-60). Thus, a POSITA would not be able to determine if any time beyond 500 nanoseconds (i.e., 501, 550, or 1,000 nanoseconds) would fall within the scope of "immediately."

83. Because a POSITA could not determine the bounds of the term "immediately" as it appears in independent claims 3, 11, and 19, the claim is indefinite.

I declare under penalty of perjury that the foregoing is true and correct. Executed this 16th day of August, 2017, at Washington, D.C.

Dr. Philip Hobbs